Status Report: Background Subtraction for Activity Recognition

I. INTRODUCTION

Activity recognition involves analysis and monitoring of activities performed by an individual or by a group of individuals. The initial preprocessing in activity recognition system involves foreground extraction. We have implemented the background subtraction method proposed by Stauffer and Grimson [1]. Further a technique to compensate for the camera automatic gain control (AGC) effect has been implemented. The problem AGC creates is that whenever a dark or bright object comes in the field of view, it changes the illumination of complete image which results in failure of background subtraction techniques. We shall illustrate this with examples.

II. STAUFFER-GRIMSON BACKGROUND SUBTRACTION METHOD

Authors of [1] modeled the pixel process by the mixture of adaptive Gaussians. This method accounts for the fact that a pixel can see multiple surfaces at different times. The pixel process is defined as the values taken by the pixel over a period of time. A new pixel is represented by one of the major components of the Gaussian mixture model, and is also used to update the model. Furthermore, there is a weight associated with each Gaussian distribution. The weight of the matched Gaussian is to be increased, and those of unmatched are to be reduced.

$$\omega_{k,t} = (1-\alpha)\omega_{k,t-1} + \alpha M_{k,t}, \tag{1}$$

where $\omega_{k,t}$ denotes weight for k-th Gaussian at time t and M is equal to 1 (or 0) for matched (or unmatched) Gaussian. Also mean $\mu_{k,t}$ and variance ${\sigma^2}_{k,t}$ for matched Gaussian get updated based on the observed pixel. The update equations are as follows:

$$\mu_t = (1-\rho)\mu_{t-1} + \rho X_t \tag{2}$$

$${\sigma^2}_t = (1-\rho){\sigma^2}_{t-1} + \rho(X_t - \mu_t)^T(X_t - \mu_t) \tag{3}$$

where X_t denotes pixel intensity at time t.

Now in order to determine which Gaussians of the mixture are most likely to have been produced by the backgroud at every pixel, the Gaussians are arranged in the decreasing order of $\omega_{k,t}/\sigma_{k,t}$. The background Gaussians are assumed to have large weights and less variance. The first few Gaussians are chosen as the background Gaussians to account for multi-modal backgrounds. After segmentation of the image into foreground and background pixels, foreground pixels can be grouped by connected component algorithms.

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14. ABSTRACT
Activity Recognition involves analysis and monitoring of activities performed by a single individual or a group of individuals and identification of the corresponding activities. The activity recognition system and a wide variety of applications.

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III. Stauffer-Grimson Background Subtraction method with AGC compensation

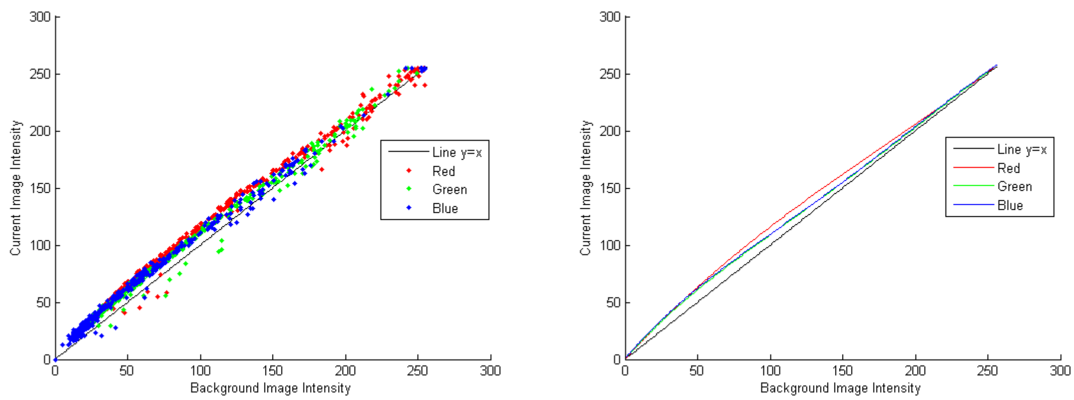
The camera AGC remains ON by default. Whenever any bright or dark object comes in the view, it changes the illumination of whole image causing failure of background estimation methods. It was shown that intensity variation caused by camera AGC can be parameterized. The best fit curve will give the intensity transfer characteristics between the best background image and current frame. Fig. 1a shows the scatter plot of pixels in the best background image and the current frame. Fig. 1b shows the corresponding best fit curve for Red, Green, and Blue components. Also new update equations will be:

$$\mu'_t = (1-\beta)\mu_{t-1} + \beta f_{b,t}(\mu_{k,t-1}) \tag{4}$$

where β is a value which decides the adjustment in accordance with AGC.

$$\sigma'^2{}_t = (1-\beta)\sigma^2{}_{t-1} + \beta f'{}_{b,t}(\mu_{k,t-1})\sigma^2{}_{k,t-1} \tag{5}$$

where $f_{b,t}$ is the derived transfer function relating the pixel intensity of background image b and the current image t.



(a)

(b)

Fig. 1: Comparison of current frame with background. (a) shows the scatter plot, and (b) shows the transfer function relating background and current image intensities.

IV. Experiments and Conclusion

Fig. 2a show the estimated background. Fig. 2b is the 430-th frame of the video. The figures Fig. 3a and Fig. 3b show the foreground extracted by Stauffer-Grimson method without AGC and with AGC compensation respectively. It can be observed that AGC compensation has improved the foreground extraction. It shows promising improvements. However sometimes this method fails. We need to do more experimentations to gain more insights.

Fig. 2: (a)Best background image, and (b)Current image.

Fig. 3: Comparison of Stauffer-Grimson method with and without AGC compensation for foreground extraction. (a) Without AGC compensation, and (b) With AGC compensation.

References

[1] C. Stauffer and W. Grimson, "Adaptive background mixture models for real-time tracking," in *IEEE Conference on Computer Vision and Pattern Recognition*, vol. 2, 1999.